Data Communication Protocols In Wireless Sensor Networks

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***Abstract*— A Wireless Sensor Network (WSN) is a wireless communication technique that consists of a number of sensor nodes, and effort to sense certain specified data around its environment. WSNs have have various applied areas. In this paper we introduce the intuitions behind WSNs, explain the main idea behind them and show applications based on WSNs. Then we will discuss data communication protocols in WSNs.**

***Index Terms*— Wireless Sensor Networks, Open System Interconnection**

I. Introduction

Wireless Sensor Network (WSN) is a group of small sized sensor that is placed in a specified area for collecting informations that we need from this short range environment. WSN is made from nodes and a control center, nodes consists of micro-controllers and sensors that are connected to micro-controllers. WSNs are purposely designed for providing the long-liftetime network by minimizing the energy consumption. In traditional networks, the position of sensor nodes are carefully choosen by engineers. Instead of this, WSNs does not need this: the position of sensor nodes doesn't need to be best-practice pre-determinated or engineered. Unlike traditional networks, a WSN has its own design and resource limitations; this sensor nodes are low power devices equipped with many sensors, a processor, transceiver, memory and a power supply, that means they present extreme resource limitations. They working collaboratively, they collect data from the periphery; periphery can be a military area, biological area (habitat), hazard or disaster area. WSN nodes monitore those areas, collect data from the environment and processes it with an on-board processor. When the area of environment gets larger, the network needs more nodes to cover this environment. Indor enviroments like greenhouse (e.g monitoring biological and thermal activities), the number of nodes becomes fewer. On the other hand outdoor environments like military areas, the number of nodes becomes more than indoor environments.

II. The Architecture

As we mentioned before, WSN has its own design and resource limitations. Thus, we cannot build the WSN with principles of the Open System Interconnection (OSI) model, like in most traditional networks. In the OSI model, we have seven layers composed as

1. **Physical Layer**, responsible for the actual physical connection between the devices.
2. **Data Link Layer**, responsible for the node to node delivery of the message.
3. **Network Layer**, responsible for transmission of data from one host to the other located in different networks.
4. **Transport Layer**, responsible for providing services to application layer and taking services from network layer.
5. **Session Layer**, responsible for establishment of connection, ensuring continuity.
6. **Presentation Layer**, responsible for extracting data from application layer.
7. **Application Layer**, responsible for displaying the received information to the user.

Unlike the OSI model, WSN is usually composed of five layers: application layer, transport layer, network layer, data link layer and physical layer.

A. Application Layer

Application layer makes low-level features easy to use for user. It is an abtraction of those low-level features. It specifies the shared communications protocols and interface methods.

B. Transport Layer

The layer that is responsible from maintaining the flow of data and congestion control. It is also used for error control and detection.

C. Network Layer

The network layer performs routing the data and self-configuration. This data is supplied by the transport data. It is responsible for link failures and provides regular updates to neighboring nodes [3].

D. Data Link Layer

Data link layer does many tasks, it is an interface between the network layer and physical layer. The data link layer is responsible for the multiplexing of data streams, data frame detection, medium access, addressing, synchronization and error control.

E. Physical Layer

It is responsible for the actual physical connection between the nodes, frequency selection, and data encryption. It convers digital bits into analog symbols.

III. Application Areas

As we described, WSNs can be used outdoor and indoor. Some of them is used for monitoring, some of them is used for tracking.

IV. Components of WPN

Wireless Sensor Networks have three main components. We can picture WSNs as a military that has soldiers everywhere and there is a commander head of them, manage them, collect data from them about the war area. Then transform these data into information and tell his superior. So we can three components here; Sensors (soldiers), Base Station (commander), Internet/Computer (superior).

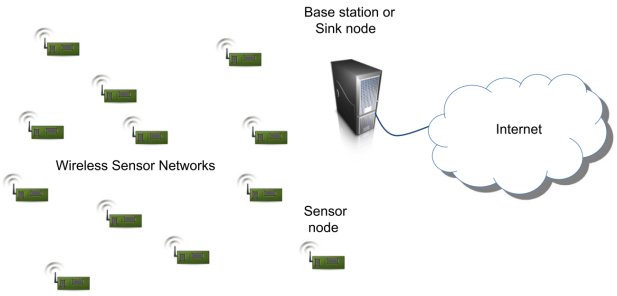

Figure 1: Components of WSN [3].

A. Sensor Node

Each network uses hundreds or even thousands of sensor nodes in it. Because of that we need to build the cheapest node as we can. Sensor node responsible for collecting data from the specified aera with its components and sending them to other nodes and the sink node. There are four subsystems in a sensor node.

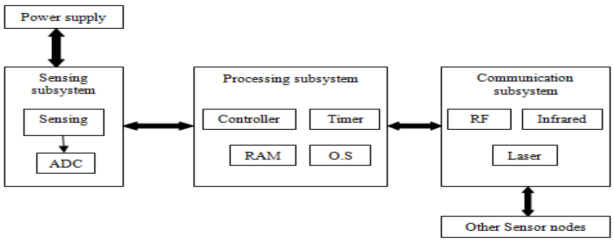

Figure 2: Components of WSN [2].

First, we need power supply to do all other things and our usage has to be less as well as we can. According to situation; batteries, rechargeable batteries and solar energy batteries can be used.
As you can understand from its name there are many sensors in each sensor node. You can see as sensing subsystem in figure for sensors. These sensors can be different kind like active sensors or passive sensors (active ones send signals to environment and infer from response for example sonar sensors, passive ones directly infer from environment for example thermometers) and different numbers according to your specific purpose. Sensing subsystem also responsible for converting the signal from analog to digital and includes ADC for convertion.

Sensor nodes also must include a microcontroller for connecting all sensors on it, collect signals from sensors and store them in its memory, you can see as processing subsystem in figure. Processing subsystem includes a microcontroller (mostly used microcontroller because other processors can be expensive and use more energy which we do not want to use more energy) and operating system which connects hardware to software (common choice is TinyOS for this [2]), timer to make synchronization between OS tasks and hardware and RAM for store sensor values.

After collection, these data need to be sent to the Sink Node directly or on other sensor nodes. For this operation we need a communication subsystem. This subsystem needs more power than the other subsystems. Because of that we should choose our way of communication carefully. We can use Radio Frequencies (Mostly used 2.4, 3.6, 5 GHZ frequency bands), Infrared (this technique does not need to antenna but its range is as much as a remote controller of TV), Laser (it uses less energy but for this technique sensor nodes must be able to see each other directly, sometimes even they see each other the weather could be foggy, this is also problem).

B. Base Station/Sink Node

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